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## Advanced Property Valuation Techniques and Valuation Accuracy: Deciphering the Artificial Neural Network Technique

Albert P.C. Chan<sup>a</sup>, Rotimi Boluwatife Abidoye<sup>b</sup>*a Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong**b Faculty of Built Environment, University of New South Wales, Sydney, Australia*

### Abstract

Property valuation end-users generally rely on property value opinion provided by valuers in making informed real estate investment decisions. However, the inaccuracy of valuation estimates could be attributed to the adoption of inappropriate property valuation methods and such inaccurate estimates could mislead real estate investors and stakeholders. This could result in individual loss and national loss due to the importance of the real estate sector to the national economy. Therefore, this study aims to examine the application of advanced property valuation techniques with special emphasis on the artificial neural network (ANN) technique in estimating accurate property values. A detailed review of the literature on issues involved in property valuation was conducted. The issues presented in this paper include the origin of ANN, its strength and weaknesses in comparison with other valuation approaches, its application both in theory and in practice, requirements for application in property valuation, valuers' response to its adoption, amongst others. It was found that the ANN technique could produce on the average accurate and reliable estimates but has not been widely adopted in practice. Thereafter, the challenges ahead in bridging the gap between theory and practice of the application of artificial intelligence (AI) techniques were discussed. In addition, the strategies of facilitating this paradigm shift to achieve a global sustainable property valuation practice are presented in this paper.

**Keywords:** Property valuation; valuation accuracy; artificial neural network (ANN); artificial intelligence.

### 1. Introduction

Real estate professionals play a significant role in the economic development of different countries around the world through the services they provide to both individual and institutional clients. These services include but are not limited to real estate agency, property management, feasibility and viability appraisal and property valuation among other. Of all these services, property valuation stands out as a service that has attracted strong public interest by various stakeholders (Gilbertson and Preston, 2005). Property valuations are usually required by real estate clients for sale and acquisition, mortgage, insurance, taxation and so on. A property valuation exercise is basically conducted by different players which include real estate agents, appraisers, mortgage lenders, property developers, among others (Pagourtzi et al., 2003). In arriving at the value of a property, valuers usually apply both mathematical and computational approaches/methods which have been categorised into both traditional and advanced methods of property valuation (Pagourtzi et al., 2003). Scholars have argued that the traditional methods are mostly unable to produce accurate, objective and reliable estimates (Zurada et al., 2006). While, advanced methods have proven to produce with speed, accurate and reliable property valuation estimate (Waziri, 2010).

Property valuation inaccuracy is being experienced in different property markets around the world at different levels (Mallinson and French, 2000), and this has attracted the attention of both real estate scholars and practitioners. Studies have shown that the adoption of inappropriate property valuation approach could lead to property valuation inaccuracies (Jiang et al., 2013). The sophistication and the objectivity of property valuation estimates required by valuation clients necessitates a shift toward the adoption advanced automated property valuation process (Gilbertson and Preston, 2005). Therefore, this study aims to examine the advanced valuation approaches with a focus on the artificial neural network (ANN) technique, that could serve as a decision support tool to estimate accurate and reliable property valuation figures.

## **2. Property Valuation Methods**

Property valuation is the estimation of the worth of an interest in a property, which involves a reflection of the subject property characteristics and the circumstances surrounding the exchange of the interest in the open market (French and Byrne, 1996), can be conducted by adopting a number of approaches. These approaches include comparable, investment, profit, development and contractors methods which have been classified as traditional methods, and on the other side, ANN, hedonic pricing model (HPM), spatial analysis, fuzzy logic and autoregressive integrated moving average (ARIMA) have been categorised as advanced methods of property valuation (Pagourtzi et al., 2003).

The traditional methods basically rely on the direct comparison from which the valuer draws conclusions on the value of the subject property (Yacim and Boshoff, 2014). Scholars have argued that the traditional methods are not capable of producing accurate and reliable property valuation estimates (Ratcliff, 1972; Zurada et al., 2006), and this has been attributed to the subjective nature of the approaches because their outputs are largely dependent on the skills and experience of the valuer (Paris, 2008). This subjectivity could render them inappropriate for estimating accurate property values in this information technology age (Gilbertson and Preston, 2005; Grover, 2016), and, hence the shift towards the advanced methods (Boshoff and De Kock, 2013). The advanced methods of valuation are decision support tools (modelling techniques) that process the property market information through software in arriving at a property valuation figure. The advanced methods have been adopted in property valuation in order to address the drawbacks of the traditional methods (Amri and Tularam, 2012; Do and Grudnitski, 1992). Although these methods usually require a large number of historical property transaction data in their application (Pacharavanich et al., 2000), they have proven to produce accurate and reliable property valuation estimates (Gilbertson and Preston, 2005).

The appropriate property valuation method adopted in a property valuation exercise is largely influenced by the amount of information available to the valuer, the use of the property, the purpose of the valuation exercise and the type of the property under consideration (Vos and Have, 1996). Also, the differences in the stakeholder's perception on the acceptability of a particular approach and real estate properties (goods) suggest the application of different methods of valuation to meet the present need (Yacim and Boshoff, 2014). Pagourtzi et al. (2003) present the details of the applications of the various valuation methods, while additional information can be found in (Lam et al., 2008). It is safe to state that none of these property valuation methods (traditional and advanced) can be applied to all the real-life property valuation exercises (Tse, 1997), hence the need for the valuer's in-depth knowledge of the submarket under consideration (Shapiro et al., 2012).

### 3. Artificial Neural Network

#### *Background, Development, Strength and Weaknesses*

Frew and Jud (2003) asserted that the emergence of the nonlinear modelling techniques addresses the shortcoming of traditional models in the area of efficiency. ANN is described as a computer system whose microprocessors are connected in parallel, forming layers and making multiple connections and mimicking and functioning like the neural network in the brain (Mora-Esperanza, 2004). In another context, Taffese (2006), describe ANN as an interaction between processing elements in a network which ultimately presents the global behaviour of the network by interpreting the relationship between the elements' parameters and processing elements.

The ANN technique was first explored by McCulloch and Pitts (1943) by using it to work out arithmetic logic functions. Thereafter, Hu (1964) adopted ANN for the forecasting of the weather. The ANN technique did not receive more attention during those early times due to the lack of multi-layer network training algorithms. The ANN model functions like the human brain by mimicking the neurons in the human brain in processing an information. The neurons are interconnected, and the information is being transferred through the connections (dendrites and axons). The network architecture of the ANN model is divided into three layers i.e. the input, hidden and output layer as shown in Figure 1. The processed data is feed into the model at the input layer, while the mathematical calculations that involve weighted summation and transformation occur in the hidden layer and the result to be predicted is produced at the output layer. Kaastra and Boyd (1996) proffer a detailed process of designing an ANN model, while Haykin (1994) and Zhang et al. (1998) among others provide a broader foundation about the ANN technique.

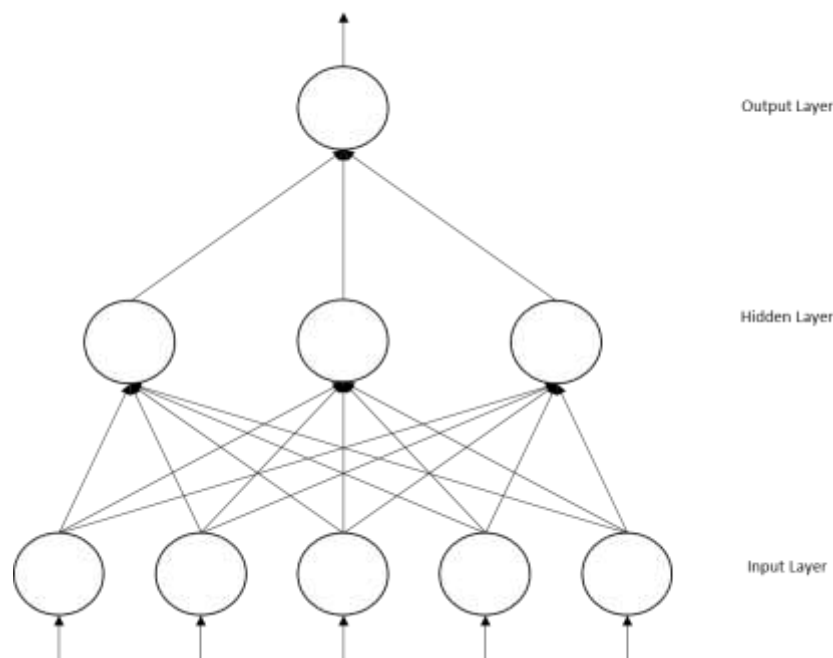


Figure 1: A typical ANN architecture

Source: Zhang et al. (1998, p. 38)

The ANN architecture which simply means the construction and composition of the ANN model have an influence on the outcome of the output. This is in terms of the number of the hidden layer(s) and hidden neurons in the model. To date, there is no generally accepted approach to design an ANN architecture to solve all real-life prediction problems. The architecture could be determined through pruning the algorithm (Cottrell et al., 1995), network information criterion (Murata et al., 1994), a grid search to optimise the parameters (Cortez, 2010) and my formula (Ward, 1996), among others. To develop an ANN model, the data available is to be divided into two parts i.e. for the training of the model and for the evaluation of the model. There is no generally acceptable division ratio, however, a splitting of the data into 80% (for model training) and 20% (for model testing) is common in the literature (Abidoye and Chan, 2017). This justifies the fact that property valuation (either traditional or advanced methods) is an art which requires the valuers skills and experience (Zhang et al., 1998).

ANN has been applied in different fields of studies due to its ability to handle complex real-life situations (Paliwal and Kumar, 2009). The ANN technique has proven to have generalization abilities (Xie and Hu, 2007) and user-friendly in terms of its operation (Borst, 1991). There exists a nonlinear relationship between property attributes and property values (Taffese, 2006), which most property valuation methods are not designed to handle. Whereas, the ANN technique could handle this and still produce accurate and reliable estimates (Cechin et al., 2000). Also, the ANN technique is objective in nature as it requires less of human interference in its application (Tay and Ho, 1992), which usually improves the accuracy of its estimates. In addition, the ANN technique has been designed to address the shortcomings of most other valuation methods. On the other hand, the ANN technique requires several historical transaction data to function, unlike other traditional methods that can be applied with as few as two comparable properties (Jenkins, 2000). Likewise, ANN has been termed as a “black box” model due to the inability to understand what happens in the internal structure of the model (Lam et al., 2008). However, works are ongoing to enhance the operation of ANN (McCluskey et al., 2012).

### *3.1 Application of ANN in theory*

As earlier mentioned that ANN was first introduced in the early 1940s, however, it was first introduced into property valuation in the early 1990s. The seminal study of Borst (1991) explored the application of ANN to a property valuation problem. The study evaluated the predictive accuracy of the ANN technique and found that the ANN technique can be adapted to estimate reliable and accurate valuation figures. Since the exploration in the real estate domain was still at the early stage, Borst (1991) advocated that more research should be directed at improving the performance of the ANN technique in property valuation. After this study, studies have been conducted to investigate the predictive accuracy of ANN in property valuation. See Abidoye and Chan (2017) for a review of the studies that have adopted ANN in property valuation. Some of those studies compared the accuracy of the ANN technique to other valuation approaches such as HPM. Although most of the studies reported the excellent performance of the ANN technique over other methods, but a few reported otherwise that the ANN technique is not totally better than HPM or that the superiority of the ANN over HPM is inconclusive.

In all, the predictive accuracy performance of ANN has been confirmed widely in the literature. Abidoye and Chan (2016a) reported that 82% of the articles that have compared the predictive accuracy of ANN with other methods reported that it outperformed others, 11% reported that their performance is equal, while only 7% percent reported that other techniques outperformed the ANN technique in property valuation. From 2000 till date, the ANN technique has been adopted in theory in different part of the world including but not limited to the USA, the UK, Hong Kong, Singapore, Italy, Greece, Spain, Australia, Morocco, Nigeria, Malaysia. However, most of the studies that have applied ANN in property valuation emanated from developed nations, while such studies are limited in developing countries (Abidoye and Chan, 2016a). This gap in the application of ANN in developing and developed economies could be attributed to the lack of the availability of robust data (Adegoke et al., 2013), which is highly

important to develop property valuation models (Grover, 2016). From 2000 till date, the ANN technique has been gaining wide acceptance by scholars in different part of the world. The results of those studies are mixed in terms of the degree of the performance of ANN and the plausible reason could be the nature of the data used (Lenk et al., 1997), difference in the socio-economic settings of the study areas (Tao, 2010) and ultimately due to the fact that no method can address all valuation problems (Pagourtzi et al., 2007).

### **3.2 Application of ANN in practice**

The traditional methods of valuation are widely adopted in practice, especially the comparable, investment and cost methods and this can be attributed to their simplicity in the application for the valuation of residential properties (French, 2004). The HPM technique which is an advanced valuation method has been adopted in real life property valuations in Australia, Sweden, Northern Ireland, New Zealand, the US and Hong Kong (McCluskey et al., 1997). Also, the fuzzy logic technique has been incorporated into the Microsoft Excel spreadsheet and used in property valuation in Birmingham (Schwartz, 1995). The ANN technique, in particular, has been adopted in the property valuation of houses in Florida and California with the use of a neural network system named Automated Real-Estate Analysis System (Areas) developed by HNC in San Diego (Schwartz, 1995). In addition, the Valuation and Land Agency in Northern Ireland usually adopt ANN in mass appraisal (McCluskey et al., 1997). ANN has been regarded as a useful tool to valuers in property valuation and this is evident in a few countries including ANN in their property valuation (Mora-Esperanza, 2004). ANN which can be referred to as an automated valuation model (AVM) has been adopted in the property valuation in The Netherlands, Lithuania, Canada and the US (Grover, 2016). To date, valuers (both in developed and developing nations) have not embraced the ANN technique (and most advanced method of valuation) in practice (Abidoye and Chan, 2016b; Abidoye and Chan, 2018). The plausible reasons for this are 1) the beliefs of valuers that a valuation exercise should be conducted by humans 100% without the influence of machines and software, and 2) the fear that automated valuations may take over the profession which may render valuers jobless (Mooya, 2011). It can be suggested that The ANN technique and the other advanced property valuation methods have not received wide acceptance from the industry practitioners.

## **4. Discussion**

It has been earlier stated that no single valuation method can be adapted to all valuation problem and the valuer's knowledge of the property market is necessary to estimate an accurate and reliable property valuation. However, it is worth noting that due to the sophistication experienced in different multidisciplinary professions related to the real estate profession, it is expedient that the global property valuation practice is being redefined to embrace technological advancement (Gilbertson and Preston, 2005). "With the almost inevitable growth of desktop valuations for residential mortgage lending, if valuers and the firms providing valuation services are to prosper, they need to be part of the solution rather than part of the problem. In other words, they need to utilise new technologies to enhance their valuation services" (Elliott and Warren, 2005, p. 367). Those new technologies are in the form of adopting advanced property valuation approaches that are computational and has proven to produce excellent results (Amri and Tularam, 2012).

Valuers have argued that the advanced property valuation approaches cannot replace the traditional methods that are regarded as being "sacrosanct" because they have been used over the years and should be continued to be adopted, but unless a positive change is embraced towards advanced valuation approaches the consequences to the real estate profession could be severe (Royal Institution of Chartered Surveyors, 1986, pp. 169-170, as cited in Boyd (1995)). With the development of big data analysis which has been yielding improvements in the real estate profession generally (Du et al., 2014), this should be embraced in the property valuation aspect of the profession to bring about a sustainable global property valuation practice. "In the past, it was the market knowledge that set

valuers apart from their competitors, but today it is what they do with that data that differentiates" (Gilbertson and Preston, 2005, p. 127). This data may not be readily available in most developing countries (Adegoke et al., 2013) and may be available in some developed countries (Walters et al., 2011). This necessitates the urgent need to strategize on the collection of robust historical transaction data in different countries around the world that is needed for the development of accurate and reliable property valuation models (Grover, 2016).

The application of ANN requires the know-how which most valuers may not possess when compared to the traditional methods. This is in addition to the good knowledge of the subject property market where the property to be valued is located. Undoubtedly, valuers will need to be trained and retrained on how to apply the advanced methods and to understand their strength and weakness, so as to be able to decide when to apply them. More importantly, the real estate professional bodies that regulate the property valuation profession in different countries would need to revisit the educational and professional standards of real estate students and valuers (Gilbertson and Preston, 2005). This could take the form of overhauling property valuation curriculums and also organizing workshops, training and conferences to discuss this issue. The extent of property valuation inaccuracy reported around the world has largely been as a result of the adoption of the traditional methods of valuation (Mooya, 2011). Therefore, there is a need to adopt other methods (advanced methods) so as to achieve accurate property valuation and eventually transform the property valuation profession.

## **5. Conclusion**

Inaccurate property valuations could have a devastating effect on the investment of individuals and corporate real estate investors and the nation at large. The property valuation method adopted for property valuation exercise could impact the accuracy of the estimates. This study examined the ANN technique as a viable tool to achieve more accurate and reliable property valuation estimates. The origin and background of ANN, its application both in theory and practice and the future direction of its application in the property valuation profession were presented in this study. Information was gleaned from the literature and were analysed and presented in this paper. ANN has received great attention by real estate scholars around the world, especially in developed economies. Most of the studies that adopted ANN, in theory, have reported its excellent performance in terms of accurate property valuation estimates when compared with other valuation methods. This actually does not suggest that ANN will solve all property valuation real-life problems accurately. On the other hand, ANN has not been widely accepted by valuers let alone adopt it in practice in many countries around the world. The adoption of the traditional methods of property valuation is still widely adopted in practice and this has not actually been able to estimate accurate and reliable property valuation figures. Hence, it is the high time all the property valuation stakeholders came together to work on the adoption of advanced methods of valuation to produce accurate property valuation figures and provide other requirements for developing reliable property valuation models. These requirements include robust historical transaction database, the training of valuers in the know-how of the application of the advanced methods, the update of property valuation curriculum in universities and other real estate learning platforms, and so on. If the advanced property valuation methods are embraced, it could reduce the time and cost of property valuation and if accuracy is being achieved, it will improve the integrity of the profession and the professionals in the public. This study retrieved the information provided in this paper solely from the existing literature. Therefore, further research would be conducted to investigate valuers' position and input on the adoption of the advanced methods of valuation in practice. Such study would bridge the gap between theory and practice which would bring about a sustainable global property valuation practice.

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